B E R I - B E R I

WITH NOTES ON THE FORM FOUND IN THE INTERIOR OF DUTCH GUINANA.

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by

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B E R I - B E R I.

In discussing this disease I have arranged the different points under the following headings:-

1. Derivation of the name Beri-Beri.
2. Nature and Definition of the disease.
3. Geographical distribution.
4. Classification of types.
5. Symptoms and physical signs.
6. Post-mortem appearances - naked eye and microscopic.
7. Etiology.
8. Spread of Beri-Beri.
9. Communicability.
10. Chemistry of blood in beri-beri.
11. Course and Progress of cases.
12. Diagnosis.
13. Prognosis.
14. Mortality and mode of death.
15. Treatment.

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DERIVATION OF THE TERM "BERI-BERI".

By many writers this name is believed to be derived from a Malay-Japanese word meaning "stiff-gait"; by others it is believed to be derived from the Malay word Biri-biri, meaning sheep. Others again have thought it was derived from a Sanskrit word "Bhara" meaning a "load" or "weight". There is a Malay word "Beri" which means swollen, and the word repeated means very swollen. This seems to me to be the most likely derivation of the name. In Japan Beri-beri is called Kakke. This word is probably analogous to the Malay word"Kaki", meaning "foot".

The derivation most commonly believed now, is that the name is derived from a Sinhalese word meaning bad-sickness.

NATURE AND DEFINITION:

Sir Patrick Manson[1] defined the disease as follows:- "Beri-beri is a specific form of multiple peripheral neuritis occurring endemically, or as an epidemic, in most tropical and subtropical climates, and also under certain artificial conditions, in more temperate latitudes." He also[2] says it is specially characterized as compared with other forms of peripheral neuritis by:

1. Proneness to oedema.
2. Implication of the neuro-muscular system of the heart.
3. By its producing no trophic skin lesions.
4. By absence of paresis of muscles of head and neck.
5. By marked implication of special organs of sight, hearing, taste and smell.
6. And of the mental faculties.

The nature of the disease was recognized by the Dutch in the Dutch East Indies in early years. In connection with work done in India on the subject in later years, Manson[3] mentions the names of Malcolmson, Carter, Waring and Morehead. Recently some very important research into this subject has been done by Hamilton Wright[4] in the Federated Malay States and by Scheube[5] of Tokio. Scheube and Baelz were the first to shew that the disease is a specific peripheral neuritis.

Pekelharing[27], Winkler[27], Ross,(37) Rost(30) and innumerable others have also been engaged on the subject.

GEOGRAPHICAL DISTRIBUTION:

The disease occurs endemically or in epidemics in most tropical and subtropical countries. In the East it is the cause of a large mortality amongst the tin miners in the Malay States. It is also a common disease in the Dutch East Indies, Japan, China, British India and Africa. Epidemics have been reported amongst the coolies working on the Panama Canal and other works. Manson[1] described cases from Lake Nyassa, the Upper Congo and Hayti.

Bolton[6] described an outbreak in Diego Garcia, an island of the Chagos group. Lately we have had reports of epidemics among natives of West Australia and also among the Chinese immigrants in Australia. There is no doubt that the endemic areas of this disease are increasing, as lately we hear of outbreaks in places in which the disease was never before known to exist, such as Havana, the Sandwich Islands and New Caledonia. Recently we have had epidemics breaking out under certain conditions, especially that of overcrowding, in more temperate climates, e.g. Conolly Norman[7] has described the outbreak of three epidemics in Richmond Asylum, Dublin, where the asylum which was built for 1000 inmates contained 1500.

The disease has also been described as occurring in the forecastles of ships lying in London Docks.[1] Epidemics also have broken out in certain asylums in France and the United States.

CLASSIFICATION OF THE DISEASE:

By the old writers the disease was simply classified as the Wet and Dry types. Scheube[8] classified the disease into:

1. The mild form.
2. The Acute pernicious form.
3. The atrophic form.
4. The dropsical form.

Others have classified the different types as

1. The paralytic form or beri-beri atrophica.
2. The oedematous form, or beri-beri hydrops.
3. The mixed form.

Hamilton Wright[9] does not consider any of these classifications correct in view of the underlying pathological lesion in the central and peripheral nervous system and alimentary tract. As a result of an examination of the central and peripheral nervous systems of about forty cases, he divides all cases into two classes, marking the active stage of the disease, and a third class, marking a residual beri-beri condition. These classes he calls:

1. Acute Pernicious beri-beri.
2. Acute beri-beri.
3. Beri-beric residual paralysis.

I shall endeavour to describe these later on in the paper.

CLINICAL FEATURES:

From a clinical point of view the disease is probably best divided into:-

1. Acute pernicious cases
2. Dropsical cases.
3. Paralytic cases.
4. Mixed form.

In describing the symptoms and physical signs perhaps it would be best to describe a case of each kind, but first a word might be said as to the symptoms common to all cases. These are:

(1) Greater or less oedema, especially over the shins.

(2) Muscular feebleness and tenderness.

(3) Anaesthesia of certain areas of the skin, especially the fronts of the legs.

(4) Implication of the neuro-muscular system of the heart, causing dyspnoea, and a tendency to dilatation, especially of the right side.

(5) Epigastric pain and fulness, especially at the beginning of the disease.

The variety of symptoms and clinical signs found in different cases of this disease is infinite, but the above signs are present in all cases and form the essential symptoms.

I shall now proceed to describe a case of each of the four different types, and shall begin with the acute pernicious form.

Acute Pernicious Beri-beri: This form of the disease is always fatal, death occurring as a rule within the first week. The following case came under my observation in the hospital of the Surinam Gold Concessions in Surinam.

Name: Jhon-Peon-Jem: Age 28; Half coolie, half Chinaman; gold miner. Native of China.

I first saw him on June 5th 1904. He came complaining of loss of appetite, sleeplessness, and a dull, grinding pain in the stomach. Temperature was 100.6°F. On examination I found slight oedema over the shin-bones, but no anaesthesia. The muscles of the calves were slightly tender on pressure, but the symptom most complained of was the pain in the stomach, and this was increased on pressure. The tongue was clean and healthy looking and the bowels had been regular up to date. The knee-jerks were slightly exaggerated, but there were no signs of paresis of muscles.

Within 24 hours from admittance the patient began to complain of dyspnoea and palpitation. On examination of the heart, the dulness was found to be markedly increased to the right. The sounds were separated by equal intervals of time, giving a galloping rhythm and a soft systolic bruit was heard at all the valves. The second sound was reduplicated in the pulmonary area. All over the praecordia there was an irregular impulse. The carotids were throbbing violently, also the external jugular veins. This was increased on exertion. The pulse was rapid (120 per minute), irregular, both in time and force, the tension was very low. Within a few hours nervous symptoms began to be very marked. Paresis of the lower limbs was very evident, the patient being unable to walk. Muscular weakness was also present, all movements of the lower limbs being opposed very easily. Voluntary flexion, extension, rotation, adduction and abduction of lower limbs were almost entirely lost. I noted also great weakness of hands and forearms. The intercostal muscles were also paralysed and the abdominal muscles were bulging and flaccid. There was total numbness of anterior tibial region and dorsa of feet, and partial anaesthesia of skin of the thighs, abdomen, chest and

upper limbs. Pain sensations were lost in lower limbs and were delayed and diminished in the hands and forearms.

Thermal sensations were diminished, but not entirely lost.

The affected muscles exhibited the reaction of degeneration in a marked degree on using the Galvanic current. The Faradic current had no effect at all.

The superficial reflexes were not much affected, but the deep reflexes were entirely absent

The urine contained no albumin or other abnormality and was normal in quantity.

On June 9th there seemed to be no marked change, but oedema showed a little in the face and over the sternum and sacral regions. The larynx also had become affected and aphonia was the result. The heart dulness had extended more to the right and dyspnoea was more pronounced.

Blood count: The only feature of any importance was a decrease in the amount of haemoglobin. The percentage was 76.

Red blood corpuscles, 4,900,000
Leucocytes 7,200

I made several other films with the hope of discovering the presence of some bacteria, but the result was absolutely negative.

The patient was perfectly conscious till within an hour or so of death, which occurred at noon on June 10th. After the first two days of the illness the temperature subsided to 97.8 and remained sub-normal till death occurred. During the last twelve hours of life, the cardiac symptoms were greatly increased. He sat up in bed, or attempted to do so, but had to be supported. The breath came in short quick gasps and the countenance was livid and drawn. Death occurred from cardiac asphyxia.

In many of these cases of the acute pernicious type, the disease is first diagnosed as indigestion, as the epigastric symptoms are so marked.

Hamilton Wright[10] says that in these cases the degree of severity of the premonitary symptoms is an index as to whether the case will become one of acute pernicious, acute, or sub-acute beri-beri.

Sometimes the cardiac symptoms appear within a few hours and are very severe. The patient looks pallid and distressed. The dyspnoea is marked and great pain is felt in the praecordial and epigastric areas, accompanied by severe vomiting. The pulse is very rapid and irregular and the beats are often unable to be felt. Death may occur within 24 hours of the attack. As a rule the nervous symptoms appear in from 20 to 30 hours, and are shortly follow-

ed by the cardiac symptoms, but not infrequently the latter appear first or simultaneously with the nervous affections. The great danger in these pernicious attacks is due to the implication of vital nerves, such as the phrenics, causing paralysis of the diaphragm; the vagi, and the cervical sympathetics. The intercostal muscles often become paralysed also.

The epigastric pain, so marked at the beginning of an attack, is said by Hamilton Wright[52] to be due to specific inflammation of the duodenal mucosa, and that of the pyloric end of the stomach. Durham[11] during his observations among cases of beri-beri in Christmas Island and in the Malay Peninsula, noticed in many cases a congestion of the fauces and enlargement of the glands of the neck, in the early stages of the disease. This I never noticed, though since reading his paper, I have often looked for it. He also says that the tenderness of the calf muscles, which most observers find so characteristic a sign of the disease, was rare in the cases which came under his notice. Like many others, he noticed that the knee-jerks were usually exaggerated at first, then completely lost.

The dropsical type: This type is also known as Beri-beria hydrops. As I had a large experience in this form of beri-beri during a residence of 16 months in Dutch Guiana, I was able to take numerous notes as to symptoms and clinical signs. I shall now describe a typical case of the disease, and after that make a few general remarks as to onset and progress of this form.

Name: Hans Hoffmeier: age 39: Surinam negro. Gold Miner. Admitted to hospital of Surinam Gold Concessions on May 10th, 1904.

The patient complained of swelling of the legs, feet, and face, of drowsiness, loss of appetite, dyspnoea, and palpitation. The temperature was normal, the tongue clean and healthy looking. Bowels had been regular up to date, but urine was growing scanty and burned him as it passed. I kept the patient in to observe the progress of the disease.

When I went to see him on the morning of May 11th, I found that what had been a slight oedema the day before was now greatly increased and he presented the appearance of a man suffering from a severe attack of acute nephritis. I examined him carefully and made the following observations:

General Appearance: The patient was greatly swollen all over. The penis and scrotum were so swollen as to be blended into one large indistinguishable mass. Dyspnoea was very marked and was greatly increased by the slightest exertion. The face was puffy and pasty-looking and the lips slightly cyanosed. The oedema, which the day before had been confined to the legs and face, and which had had a hard, elastic feeling, was now general all over the body and had become softer and more like that found in renal or cardiac dropsy. The skin was dry and scaly, the hair bristly and stiff.

In the nervous system the changes were not very marked. There was a slight numbness over the pretibial regions and the tips of the fingers were also more or less numb.

Urine: This was very scanty and high coloured, but contained no trace of albumin. Sp.gr. was 10.26. Acid reaction.

Heart and Circulation: There was a diffuse pulsation at the lower end of the praecordia, and also in the epigastrium, due to dilatation of the right ventricle. The heart dulness was slightly increased to the right.

On auscultation the sounds were again equally spaced. The systolic bruits were present at all four areas and the second sound was reduplicated in the pulmonary area. The pulse was regular enough, but of very low tension and increased on exertion.

Alimentary System at this time showed no changes, except slight epigastric discomfort. As the case progressed I found an increase in the symptoms and signs in all the systems affected. The oedema which was at first quite symmetrical began to disappear in certain parts, e.g. the left leg first became clear of it, then the left upper limb and the face. As the case went on it disappeared and reappeared here and there, but four weeks after admission the patient had a severe diuresis, passing as much as 112 oz. of urine in 24 hours. This lasted for about 60 hours, and was accompanied by severe sweating attacks. At the end of that time the oedema had quite disappeared and never returned. From time to time the patient had a roseolar rash on his skin, especially after sweating attacks. It was difficult to make it out well, as his skin was almost black.

The numbness of the pre-tibial region continued, but did not increase much. The pulse became rapid, irregular and of very low tension. Dicrotism was

very marked. The wave of the pulse was of great interest. It shewed an abrupt upstroke, followed rapidly by a precipitate down-stroke. On the tracing the dicrotic wave was well marked.

Blood Count: Here the diminution in the percentage of haemoglobin was very marked. The following is the result of the examination:

Red Blood corpuscles,	5,280,000
Leucocytes	8,200
Haemoglobin	64%

In the films which I prepared, I found the presence of filaria nocturna and also the ova.

Slight numbness was found in the flanks and over the sacrum, but soon disappeared. Superficial reflexes were normal all the time. The deep reflexes seemed normal for the first week, and even a little exaggerated. After that, however, they became less and then entirely absent.

Thermal and pain sensations were healthy. Atrophy of muscle fibres was present and great tenderness of calf muscles and of those of the upper arm. The reaction of degeneration was marked in the calf-muscles, but in others the reaction was quite normal. There was marked ankle-drop, due to paresis of the extensors, but no wrist drop was present. He had

difficulty in walking, due to mechanical interference from dropsy and this, of course, was increased by the ankle-drop resulting in a high steppage gait.

The circulatory system became more affected as time went on. The dulness to the right became more extensive and in addition to the pulsations already mentioned, we also noted pulsation in the arteries and veins of the neck. The bruits became very marked and also the accentuation and reduplication of the pulmonary second sound. The action of the heart became more irregular and rapid and some pericardial effusion supervened later.

In this case the lungs were at first quite healthy, but later oedema of the lungs appeared and this was followed by a certain amount of pleural effusion.

In the alimentary system there was nothing of note. The tongue remained clean and the bowels regular. There was no epigastric pain at first, but later he complained of some discomfort there, due probably to a certain amount of dilatation of the stomach. A few haemorrhoids appeared about three weeks after admission, due most likely to backward pressure in the circulatory system.

The urine remained scanty for a long time and

I had to use pilocarpin and other diaphoretics pretty freely. About 10 days after admission, there was suppression of urine for two days and death seemed inevitable, but he rallied from it after a very anxious time for us. The urine was acid in reaction and the sp.gr. varied from 1023 to 1027. There was never any albumin, sugar or blood present.

The danger from cardiac dilatation was the important point in this case. After the attack of diuresis and the accompanying disappearance of the oedema, I had some hope of his recovery, but on the 12th July he had an acute cardiac attack. This was complicated by the presence of oedema in the lungs and dilatation of the stomach. He had a very distressing time for a period of 24 hours before death. He sat up in bed with livid face and heaving chest, fighting for breath. He died about 4 a.m. on the morning of July 13th.

In the dropsical type of beri-beri we get an infinite variety of cases. In some the oedema may be general all over the body; but the external genitals may entirely escape. In others the external genitals may be principally affected. In many cases the oedema may be unilateral to begin with. The

oedema may rapidly appear, disappear and reappear. This has been noticed by many observers, especially by Mosse[12] during his residence amongst the Boer prisoners in St.Helena.

In the dropsical form the symptoms usually begin very abruptly. In this it differs from the paralytic form, where the onset is usually very insidious. The oedema, as already seen, is at first hard and elastic, but later becomes soft and like the anasarca of renal or cardiac disease. This is due to the fact that the primary hard oedema is caused by implication of vaso-motor fibres, but later in the progress of the disease, when the cardiac nerves become affected, and the heart becomes weak and irregular in action, we get backward pressure results, including anasarca and serous effusions, and this new anasarca, of course, is really a cardiac anasarca. In this form of beri-beri, as in other forms, the temperature may at first be raised owing to interference with the nerve endings which subserve thermal sensation, but as a rule there is no abnormal temperature throughout the case.

Sometimes we get pericardial effusion to an extent great enough to render the pulsation over the praecordia invisible on inspection.

Hydrothorax and Ascites are usually present, though it is noticeable that the amount of fluid in the serous cavities of the body is usually smaller in amount than one would expect to find.

In this type, anaemia is usually a well-marked feature - much more so than in other types.

Sometimes bilious vomiting with tenderness of the liver is found, but it is more common in the mixed type.

In advanced cases I have seen expectoration of blood, and in these cases where I have been allowed an autopsy, I have always found the presence of pulmonary apoplexies in the lungs.

This type is the rarest of all in most countries where beri-beri is found, but in the interior of Dutch Guiana it is the usual form found. By many of the Dutch medical men in the colony it was considered to be of the nature of an epidemic dropsy such as that described by McLeod[13] as occurring in certain parts of India and in Mauritius during the cold seasons of 1878-79-80. Until I went up to the gold-bush in Surinam in 1903, the beginning and progress of this disease had never been studied in that colony. I am fully convinced that it is a type of beri-beri. Dr Fowler[14] in his paper "Does beri-beri exist

undiagnosed in British Guiana" describes a disease which closely resembles beri-beri, but differs from it in the following points:

(1) Sudden death is rare.

(2) Cardiac failure is rare.

(3) Recovery is rapid.

When in British Guiana a year ago, I made inquiry into the characteristics of this disease and found that

(1) It occurred epidemically.

(2) It occurred in certain limited areas

(3) It occurred most frequently in damp, unsanitary places.

I myself was inclined to think it was a mild form of beri-beri, even though death was rare, especially sudden death; and the fact that rapid recovery took place in many cases is certainly no proof that the disease is not beri-beri, as in many cases of this disease, especially in paraplegic cases, I have seen the patients make a very rapid recovery. The disease described by Fowler was of a dropsical nature.

Paraplegic Type: This type is also known as the paralytic type or beri-beria atrophica.

Its early stage might be compared, according to its severity, with the acute or subacute form described by Dr Hamilton Wright. Where complete

recovery does not occur, but the patient is left with dilated heart, or nerve endings in a state of degeneration and is liable to repeated exacerbations and relapses, the condition compares with his "residual paralytic" type.

I shall now proceed to give a typical case:

Smith: age 26: gold miner: Native of Trinidad. I found this man lying in a hut while on my daily rounds and had him removed to hospital at De Vies Creek, Surinam, on May 12th, 1904. He complained of sleeplessness, and a feeling of depression, also pain and cramps in the muscles of the legs and thighs. He was not able to walk well, so I had him removed in a wagon.

On examination, I found he had slight oedema over the anterior-tibial regions, accompanied by very slight numbness, which was also present on the dorsa of the feet. The calf muscles were tender on pressure and he had also slight pain on pressure in the epigastrium. As we had a large number of cases of beri-beri at the time, I kept him under observation for a day or two. The day after admission he had a slight feeling of distress in the praecordia. I examined him again and found pulsation in this area but no increase of dulness. There were no bruits present, but the heart's action was rapid, though

regular. No other nervous symptoms had appeared and no increase of oedema. Three days after, when I entered the hospital, I found the patient much better. All symptoms had disappeared and he wished to go out to work. As I knew how liable these cases were to relapse, I put him on the staff of hospital attendants, so as to observe his progress. On the 25th of May, when I went to the hospital in the morning, I found that Smith was again ill.

He complained of pain in the epigastric and praecordial regions once more. The oedema had returned to the pre-tibial regions and now the numbness of skin was well marked, not only in the oedemic region, but also on the dorsa of the feet, the thighs, certain areas of the trunk and in the hands and wrists. The forearms were unaffected, but the upper arms were slightly dull. There was great weakness of muscles especially of the lower limbs, but the patient was able to extend and flex the legs and thighs, though his movements were somewhat easily opposed. The calf and thigh muscles were so tender that he cried out when they were pressed even to a slight extent. The muscles of the lower limbs exhibited to perfection the reaction of degeneration.

A.C.C > K.C.C

A.O.C. and K.O.C. were negative.

Pain sensations in the affected areas were present, though delayed and weakened. Thermal sensations were quite normal. Superficial reflexes were normal, but the knee jerk was entirely absent.

The heart's action was inclined to be rapid and soft blowing bruits were present, systolic in time. That in the tricuspid area was especially marked. The second sound was reduplicated in the pulmonary area. The pulse was much weaker than one would have expected from the force of the heart's action. It was of very low tension, rate 92, but was quite regular. There was very little increase of dulness to the right and no pulsation to speak of in the neck.

The alimentary system seemed quite healthy except for the pain in the epigastric region, which was continually present and increased by drinking milk and by pressure. The tongue was clean and the bowels were regular. There was no temperature throughout the whole case. The urine was normal in quantity, and contained no abnormal constituents. It was acid in reaction, sp.gr. 1023.

As the case went on, the muscles became much weaker and atrophy began to appear. He wasted away till he became an absolute skeleton. He was able to walk with assistance and his gait was most character-

istic. Ankle drop was very marked, so a high steppage gait was the result. The knee-joints, ankle-joints, hip-joints, elbow-joints, and wrist-joints seemed to be peculiarly loose and his control over them was very much decreased.

The interossei muscles of the hands became greatly atrophied and his grasp was very feeble, and the hands resembled the claws of a bird.

The organs of special sense escaped for the most part. Some blindness at night was complained of and also a certain amount of exophthalmos was present. Ophthalmoscopy revealed nothing abnormal. About 17 days after his relapse the muscles of the larynx became affected and aphonia was the result. No tremors were present at any time. During a large part of his illness the patient was very drowsy and somtimes difficult to rouse.

During the progress of the case the heart became more dilated and dulness to the right increased. While at rest its action was usually regular though rapid, but on the slightest exertion it increased its rate and became very irregular. The spacing of the heart sounds was very marked when the patient was lying quiet, but was lost of course on exertion. Dyspnoea was very slight except when the patient was disturbed.

All through the case the lungs remained healthy, though there was a slight pleural effusion on the right side of the chest which persisted till the case was discharged.

After the case had been in the ward for seven weeks the epigastric pain and the muscular tenderness disappeared, so I began to use massage and the electric current. The muscles then began to gain in strength and thickness, and other symptoms slowly disappeared. By the use of digitalis and strychnine and a nourishing diet, he slowly gathered strength and 13 weeks after his first admittance he was well enough to be sent down to the coast and left the country for his own Island.

I found afterwards that this man had been employed in the country for about 10 years, having immigrated there when about 16 years old. Though he told me he had never had any complaint of that kind before, I was informed by a mine manager who had formerly employed him that he had had several attacks more or less severe while working on his mine.

The paralytic type of beri-beri shows a very great variety of cases. It is wonderful to note the recuperative power of such as do recover. There is also great variety in the areas affected. In some it is confined to the lower limbs, in others the

upper limbs may be affected as well, and in others the whole trunk also. The intercostal muscles and abdominal muscles often become weak and atrophied. The facial muscles are never affected. In fact, as a rule it may be said that the cranial nerves from the 7th upwards, escape altogether. I have never seen affections of smell, taste, or hearing, though Manson[2] insists that these are marked features in many cases.

The mental faculties as a rule escape, and the patient remains quite clear-headed during the whole of his illness. Of course in dropsical cases especially where suppression of urine sets in, they are very liable to attacks of uraemia, ending in coma. The great danger in this form, as in the acute pernicious form, lies in the implication of vital nerves. The atrophy and paresis of voluntary muscles is not really dangerous to life, but when we get affection of the diaphragm and cardiac muscle, the prognosis is bad. In this type there is always a certain amount of cardiac affection and in fatal cases fatty degeneration of the heart is always present, but not so marked as in the acute pernicious form. In many of these paralytic cases the patient recovers to a

certain extent, but is liable to relapses, especially if he stays in the endemic area. A persistent dilated heart or a degree of deformity from nerve degeneration is often his portion. Many cases, however, make a complete recovery, and if the rest of their lives is spent in a country free from beri-beri no relapse occurs. The mortality in the paralytic type varies exceedingly. It all depends on the nerves attacked, but I think it may safely be said that it is much less than in the dropsical form.

Here perhaps I might add a word as to the mild type of the disease In such cases the only symptoms present may be

(1) Slight oedema of pretibial regions.

(2) Slight numbness of same areas.

(3) Slight tenderness of calf muscles.

(4) Impairment of knee jerks.

These cases, as a rule,make a good recovery, though recurrence is frequent. Sometimes even in these cases death occurs from affection of the heart.

It has been amply proved by all observers that one attack of this disease confers no immunity on the subject, but renders him more liable to future attacks if he returns to any country where the disease is endemic.

During the 3rd and 6th weeks of the patient Smith's stay in hospital I examined his blood, with the following result:

	3rd week	6th week.
Haemocytes	5,120,000	5,024,000
Leucocytes	7,400	7,450
Percentage Haemoglobin	88	83.

There were no abnormal leucocytes present, and no filariae. The faeces were absolutely free of the ova of any intestinal parasites.

Mixed Form: Of this type very little need be said. In fact, I think that all cases of beri-beri are really mixed. One never comes across a case of the disease where a certain amount of oedema and a certain amount of paralysis is not present. In the mixed form we usually find oedema of the shins and feet, also of the flanks, over the sternum, and sacral regions, and a certain amount of puffiness in the face. This oedema is of a hard nature, but in later stages where the heart is much affected it often becomes softer. It is very fugitive in nature and disappears and reappears very rapidly. It is often unilateral or irregular in its distribution.

Numbness is present in the affected areas and the calf muscles are always somewhat tender. Pain and thermal sensations are seldom affected. The knee jerk is often exaggerated at first; later it may become impaired or be absent. Superficial reflexes are always healthy. The gait is usually more or less ataxic and ankle drop may be present. The heart exhibits signs of dilatation, usually, and bruits and pulsations over praecordia and in vessels of neck are usually present. Oedema of the lungs is rare.

The pulse is always in a state of low tension and the wave is ample, both upstroke and downstroke being very abrupt.

The blood is usually normal, though slight diminution in haemoglobin may be noted.

The urine may be normal in quantity or rather scanty and high coloured. I have never seen any abnormal constituents present, except in one case where there was a trace of albumen. The general health of the patient is always good. At first there may be a slight degree of temperature, but it never persists long.

In this type there is great liability to acute heart attacks, so the prognosis must always be a

guarded one. Many of these cases seem to be progressing well, but a sudden cardiac attack may set in and the patient may die very suddenly from syncope or cardiac asphyxia. In this form also, paralysis of the diaphragm is very liable to occur. The onset of the mixed form is always an insidious one. Symptoms appear and disappear and often months pass before the patient consults a medical man.

The duration also varies greatly. Recovery may occur in a few weeks or the symptoms may persist for years to a certain extent. The peripheral nerves seem to regenerate to a certain extent, and then a relapse occurs once more. As many of these cases are lost sight of, it is difficult to estimate the mortality.

POST MORTEM APPEARANCES:

In Case No.1 there were many points of interest to be noted.

The brain weighed 3 lbs., 8 oz. The tissues were slightly oedematous, and congested. Many of the smaller vessels exhibited along their course minute miliary aneurisms. The cerebro-spinal fluid was increased. The lungs were healthy - the pleura contained no fluid. Right lung weighed 22 oz., left

19 oz. Heart was very large - weight 13 oz. Whole organ was congested. Right auricle and ventricle were much dilated and full of blood clot. Walls of heart were thin and exhibited fatty degeneration. Left ventricle was empty and showed no dilatation or thickening. Tricuspid valve was incompetent, others normal. Pericardium contained no fluid, but was congested and flabby.

The liver was large - weight 54 oz. - substance was dark with congested blood.

The spleen weighed 10 ozs. and was deeply congested - no infarctions present.

The right and left kidneys weighed 5 and 4½ oz. respectively. The substance was congested. The duodenum and pyloric ends of the stomach showed a very slight congestion, but no haemorrhages were present. The intestines were in a healthy condition - no parasites present.

Peritoneal cavity contained a very small amount of fluid, which was clear and of a yellow colour. The spinal cord exhibited no changes, but there was an excess of fluid.

Microscopically: The cerebral and cerebellar cortical cells showed no change. In fact, in neither the brain or spinal cord were any changes visible,

except what looked like a sort of cloudy swelling of nerve cells.

The peripheral nerves showed a certain amount of perenchymatous degeneration, both those to the voluntary muscles and also those to the heart, also the afferent fibres.

The liver and spleen exhibited a certain amount of malarial pigmentation, the kidneys were healthy though congested. The duodenum and pyloric end of the stomach showed congestion, but no other change. Bacteria were absent. There was some infiltration of leucocytes in the glands of the duodenum

Case No.2. There on inspection the signs of recent dropsy were very evident. The skin, in places, was cracked, and all over there was a decided looseness.

Nervous System: Brain and spinal cord were soft and oedematous and the vessels contained a large amount of dark blood. The brain weighed 58 oz.

The heart showed most important changes. It weighed 13½ oz. and was very dark in colour, the surface veins being greatly congested. The right auricle and ventricle were greatly dilated - the walls being thin and flabby The cavities were fill of dark brown clot. The left ventricle was

dilated and hypertrophied. The wall of the left ventricle was 20 m.m. thick. The left auricle and ventricle contained a small amount of fluid blood. There was no fatty degeneration of the heart muscle. Both mitral and tricuspid valves were incompetent.

The pericardial sac contained 80 cc. of clear straw-coloured fluid. Walls of the pericardium were congested and soft. The lungs were soft and oedematous and showed several areas of haemorrhage. Both pleural sacs contained a quantity of fluid. On the right side there was 80 cc., on the left 96 cc.

The liver was enlarged and weighed 61 oz. The tissues were congested and soft. The spleen weighed 7 oz., the right and left kidneys 6 and 4½ respectively.

The peritoneal cavity contained 180 cc. of clear yellow fluid. Mucous coats of stomach and duodenum were healthy looking.

Microscopically: The only changes noticeable in the nervous system were a slight degeneration of the peripheral nerve endings. The liver, spleen and kidneys showed congestion and cloudy swelling. There was no change visible in the duodenal mucosa.

Paralytic Type: Here the changes are mainly nervous. In cases where death occurs within the first few weeks we may see no changes in central nervous system, but degeneration of peripheral nerve endings is very marked. I have never had the opportunity of inspecting the organs of a case of chronic beri-beri of the type called by Wright the residual paralytic form. He has published the results of an examination of the central and peripheral nervous systems of about 40 cases[15] of beri-beri, including acute pernicious cases, acute cases and paralytic residual cases. In the former two types the changes in the central cells are not very marked, but the peripheral nerve endings exhibit Wallerian degeneration. In residual paralytic cases he has noticed marked changes in all the cells of the spinal column from the second segment downwards.

He says there is as a rule no structural change to be seen in the cerebral or cerebellar cells except a hydrolytic change, due to the increase of the cerebro-spinal fluid.

In the nuclei of the cranial nerves affected and in the cells of the anterior cornua of the spinal column, and the posterior ganglia, he found great changes. The cells exhibited marked atrophy.

They were almost colourless and greatly vacuolated. The nuclei were swollen and eccentrically situated. In the posterior spinal ganglia, the cells exhibited, in addition to these changes, a deep granular pigmentation. The affected nerves showed marked parenchymatous atrophy extending up for a few inches. Interstitial changes were also noted, and slight appearances of regeneration in many of the nerves. The lesions found in the cells of nuclei resemble very closely those found in the nuclear cells in alcoholic neuritis. There also we get dislocation of nuclei, vacuolation and chromatolysis.

In these chronic cases fatty degeneration of the heart is always present and is well shewn by staining with osmic acid. The liver, spleen, kidneys, duodenal mucosa and gastric mucosa, may show cloudy swelling and congestion, but never any change of importance.

ETIOLOGY:

There is perhaps no disease into the etiology of which so much research has been made, with so few satisfactory results as Beri-beri. Sir Patrick Manson in his book on Tropical Diseases very wisely includes it amongst the group of "General Diseases of Undetermined Nature".

Perhaps the only point on which all observers are agreed, is that the disease usually occurs where many persons live together, as in institutes. The more one reads on this subject, the more confused does one become. Theory after theory has been advanced with what seems to be strong evidence in their support, only to be contradicted and refuted.

Meteorology and Climatology:

In countries where we find a hot and cold season, the disease is much more prevalent during the former. In the East the direction of the Monsoons seems to influence outbreaks of it. From April to September while the South-west Monsoon is blowing, the driest time of the year prevails. During this season the mean temperature is higher, but the variation in temperature is less. During the North-east Monsoon which blows from September to

March the nights are cool, but it is fairly hot through the day. The variation in temperature is greater and the atmosphere is more humid. At this time the outbreaks of epidemics are greater.

In climates where there is a decided wet and dry season, such as in Dutch Guiana, the disease is much more prevalent during the wet season. At this time the daily variation in temperature is very great. During the day it may be 90° to 95°F., but at night it drops as low as 70° or even 65°. The air is damp and heavy mists hang along the ground to a depth of 10 or 12 feet.

Racial Influence : Amongst Europeans in the tropics who live on ordinary European diet and live the usual social and hygienic life common to the inhabitants of all British tropical stations, beri-beri is practically unknown. I have heard of cases occurring, but I never saw any myself.

Amongst Eurasians also, it is very rare. I have seen one or two cases in Dutch Guiana amongst people born of European fathers and Indian coolie women.

Amongst the Malays in the Federated Malay States the disease is seen, especially amongst those living in larger towns. Amongst those living in the jungles,

it is said by Dr Hamilton Wright[16] to be very exceptional, but Dr L. Braddon[17] of Negri Sembilam says they are very susceptible to the disease and quotes a mortality of 140 per thousand. But as he (Dr Braddon) classes all cases of dropsy as beri-beri, his evidence is not very reliable.

Amongst the Tamils in the Malay States the disease is seen especially amongst those of low caste, who are spirit-drinkers and do not stick to the teaching of the Koran in regard to diet, cleanliness, &c.

Amongst the Chinese and Javanese this disease is very common, especially amongst those who work in the tin mines of the Malay states

In Dutch Guiana I noticed that half-caste Chinese and Negros were especially liable to the disease, and when attacked suffered very severely.

I am inclined to think, however, that the influence of race is not of much importance. I think that members of any race, who are confined in large numbers in an area in which the disease is endemic and who are weakened, from former illness or unsuitable diet, are liable to the disease.

In the gold mines of Suriman we had an infinite variety of native races; but, with the exception of those of Chinese origin, who suffered most, there was no marked difference in the numbers of each race affected.

Age:

The disease is commonest between the ages of 15 and 30. It is seldom found in childhood or extreme old age.

Dr Francis Clark[18] of Hongkong, recently described an outbreak amongst the children in a blind asylum in that place. From here it spread to a foundling home for Chinese children and in the latter place 69 out of 102 children suffered. All the children were between the ages of 4 and 7 years.

Sex:

Amongst females as a rule beri-beri is rare. Males are more commonly attacked, but this may be due to the fact that in most places where beri-beri abounds the proportion of women to men is very small.

Dr Hamilton Wright[19] from his experience of beri-beri in the Malay states has come to the conclusion that females of all races are susceptible to the disease to the degree to which they live under the conditions that induce it in males.

Effect of locality and altitude:

The disease occurs most frequently in low-lying swampy districts, and especially in places covered

with virgin forest, where the sun never penetrates. It is very common in the low-lying cities of Japan. In Dutch Guiana I found it occurred along the low-lying banks of the rivers, but on the hills in the interior it was entirely absent. It is an important fact that patients suffering from the disease begin to improve when removed to high localities. On the property where I resided in Surinam, we had a small mountain 2,000 feet high. On the top of this we had two camps, in neither of which did we ever have an outbreak of beri-beri. Here we made a large clearing and built a hospital, to which we removed all our beri-beri cases when possible. The result was a decrease in the mortality and a rapid improvement in individual cases. The mortality fell from 20% to 4%.

Overcrowding:

There is no doubt that overcrowding, while it cannot be called a primary cause of the disease, certainly influences the outbreak and severity of epidemics. We find epidemics very frequently in many of the large over-crowded cities of Japan and China.

Dr Conolly Norman[20], in a paper entitled

"Beri-beri in Temperate Climates", describes three epidemics which occurred in the Richmond Asylum in Dublin, where the building which was built to accommodate 1000 patients held over 1500. Still, we find the disease breaking out in many places where there is no overcrowding, e.g. in the Jail at Knala Lumpur, where Wright made so many observations, there was no overcrowding, and the same can be said of the foundling home mentioned by Clark, where the disease broke out amongst children.

Occupation:

In endemic areas, men of all occupations are liable to the disease, but miners in places where food is bad and usually salted, are especially liable to it. R. M'Lean Gibson[21], in his paper "Beri-beri in Hongkong", states that there it is most frequently found amongst coolies. The next most frequent sufferers are carpenters, who probably contract it in the process of cutting up infected wood. Sailors also frequently suffer, also people employed in sedentary occupations, e.g. tailors, cooks, and barbers. Fishermen seldom suffer from it - in the fishing villages and amongst the fish-curers along the different coasts it is very rare.

Ship Beri-beri

Here it is favoured by damp forecastles and over-crowding in those places. Exposure also favours its outbreak.

In European waters it is most frequently seen amongst Lascar crews who huddle together for warmth to the exclusion of ventilation.

Mr Turner[22], who used to be Deputy Port Officer in Cape Town, recently wrote an interesting article on this subject. He believes the poison is acquired by ships while loading timber in tropical rivers, and is brought on board along with damp timber and ropes. The crews are rendered more susceptible through hard work, fever, and great exposure. He says, as a rule it does not break out till late in the voyage; when it breaks out early, he accounts for it by the fact that the men are probably rendered more susceptible owing to malaria and to the drunken debauches usually indulged in when in port. When it is delayed it is probably due to the fact that the poison has increased in virulence, while the men owing to exposure, change of climate, etc., have become weaker.

Dr T. H. Haynes[23], in his paper "Notes on Beri-beri in the Australian Pearling Fleets" finds that the disease does not, as a rule, occur till after

seven months out from port, and is mitigated by the substitution of wheat, beans, potatoes, etc. for rice.

Theories as to Etiology:

The theories advanced are innumerable, but the theories of recent writers may be grouped under the headings:

(1) Dietetic theories.

(2) Germ theories and toxic theories.

(3) Parasitic theories.

(4) Theory of arsenical poisoning.

Dietetic Theories: One of the first and most important of these was the nitrogen-starvation theory. This received a number of supporters, especially in the East, chief amongst whom was Takaki[23a] of Japan. The theory received great support from the fact that the disease, which was very prevalent in the Japanese Navy, was much decreased by giving a diet containing a large amount of nitrogenous products. But we must bear in mind that along with this improved diet, improved hygienic measures were adopted, and these may have been the main cause of improvement. The theory of nitrogen starvation has been effectively eliminated by Wright's observations in the Gaol at

Kwala Lumpur, where the diet given contained nitrogen in the proportion of 1 N to 12 C, whereas the physiological requirement is only 1 N to 15 C. Wright found that as a result of this diet there was no decrease in the incidence of Beri-beri in the prison.

The ingestion of dried fish infected by a Trichina, has been given as a cause of the disease by Gelpka[54].

The ingestion of certain kinds of raw fish has been advanced by Muira.[55] Grimm[35] thought it was due to the ingestion of infected fish. All these theories have been refuted by many observers. It has been noted that in the fishing villages on the Malay coasts no beri-beri is found amongst the fish-curers, and if fish were a cause they would surely suffer. Again, amongst Tamils who are great fish-eaters, it is a rare disease.

An epidemic of beri-beri in Poulo Condor, Cochin China, rapidly disappeared under a regimen of fat pork, and this gave rise to the theory that the disease was due to a deficiency of fat in the diet. This theory was introduced by Bremand, a French writer, and is referred to by Clark[24].

Mouldy rice has been advanced as a cause of the disease. This view has been disposed of effectually by experiments in the Gaols at Kwala Lumpur by Wright and Travers. The rice supplied to both gaols was the same, but those in the healthy gaol remained unaffected. Again, when the rice supplied was carefully steamed before using, so as to kill the spores, no abatement of the disease took place in the unhealthy gaol.[25a].

Nightingale[44] has observed that in Bangkok where fresh rice is plentiful, the disease is rare. Amongst the Tamils in the Malay States it is rare, as they decorticate their rice only after it is boiled, but amongst the Chinese and Malays it is common, and they use rice which has been husked a year or more. This seems to imply that the husk contains some cause for the disease. I have never had any reason to believe this.

From my own observations I have come to the conclusion that deficiency of any particular constituent in diet has no effect in causing beri-beri, though I have no doubt that where a man has to live for a lengthy period on an unsuitable diet, such as tinned and salted meats, tinned vegetables and tinned fruits, with no fresh foods, he is rendered more liable to

attack, if he is living in an endemic area, where the germ of the disease is in the soil.

On all the gold-mines in Surinam the diet supplied to labourers is the same and is regulated by Government. The following weekly ration was supplied to each man:

Salt beef	.75 kilo.
Salt pork	.75 kilo.
Salt fish	1 kilo.
Flour	2 kilos
Rice	3 kilos
Peas or beans	1 kilo
Sugar	.25 kilo.

Yet we found that while epidemics of the disease were frequent in many of the camps, in others, though quite close and though the same diet was given, there was no presence of the disease. Again, amongst the Boer prisoners in St. Helena, beri-beri was rife, and was really imported there by them. The Boer camps and British camps were close to each other, but the British escaped, though the food for both camps was practically the same. These facts were noted by Dr Mosse,[26] R.A.M.C.

Germ Theories and Toxin Theories: Pekelharing and Winckler[27] claim to have discovered and made cultures of several bacteria, both bacilli and cocci, in the blood of beri-beri patients, and to have induced symptoms of beri-beri in lower animals by inoculation.

These claims are very doubtful, and are not yet accepted by the majority of authorities.

Dr Hamilton Wright[28] examined the blood of 75 cases and found that in 68 cases no organisms were found. In the others by culture, growths of S.pyog. citreus; S.pyog.aur., and S.pyog.alb. were found. Some of these were considered by Pekelharing[27], Winckler[27] and Van Ecke[56] to be associated with beri-beri, but as the same organisms are found in cultures made from the unwashed skin of Orientals, they cannot be regarded as characteristic of the disease, but are probably due to contamination.

Dr F. Fajardo[29] has described a unicellular organism in the blood, which is found both inside and outside the haemocytes. It is smaller than the malarial organism, but like it, it forms pigment and undergoes a cycle of development.

Capt. Rost[30] considers it to be due to a micrococcus inhabiting rice In experiments with various rice-liquors and fermenting rices he produced symptoms of beri-beri in fowls. This organism he claims to have found in the blood and cerebro-spinal fluid of beri-beri patients. He cultivated it in beef-broth, blood, pleuritic fluid and ascitic fluid.

He describes the organism as a diplococcus which develops by spores, which split up into two

and grow out into rods. It is easily stained by carbo-fuchsin. He found it in the blood of 32 cases. He says a temperature of 220°F. for 9 hours is required to kill the spores.

Dr A. Van der Scheer[31] considers the disease to be due to a parasite in the intestine which gives off a nerve poison. He considers that the parasite has an extra-corporeal existence in Blatta Orientalis (the cockroach). He thinks man becomes infected by blatta excrement. H. Noble Joynt[32] in observations made during an epidemic amongst Japanese coolies in Fiji, found that though the Japanese lived in close proximity to Indian coolies in houses swarming with cockroaches, the Indians entirely escaped, though their habits were dirty and those of the Japanese cleanly. The Indians and Japanese worked together and had much the same food. Joynt considers the disease to be due to a slowly infective germ carried by man, clothing, etc., and propagated by direct contact and by dwelling in a house saturated by germs. In the epidemic described by him the Japs and Indians worked together, but did not live under the same roof, and so were not in close personal contact with each other.

The haemic plasmodium theory which has been advanced by Glogner and others has received no support. Undoubtedly the plasmodia found are of a malarial nature.

Sir Patrick Manson [33] has advanced the following theory:

Beri-beri is due to a toxin which is the product of a germ operating in a culture medium outside the body. This toxin enters the body not in food or in drinking water, but through the skin or by inhalation.

He very aptly compares this toxin with alcohol, where the yeast germ by acting on maltose produces a toxin which has the same power of poisoning nerves as the toxin of beri-beri. He supports his theory by the fact that patients removed from endemic areas rapidly improve, and this improvement he considers would be slower, if the germ were actually present in the body. He quotes Dr Travers[34] experiments in the gaols of Kwala Lumpur to prove that it is not conveyed in food.

He also proves that it is not conveyed in drinking water, by the fact that in the case of two gaols in Singapore, which were situated close together and supplied with the same water only the inmates of one suffered.

He considers the virus to be conveyed to man either by the air, through the skin by contact or by means of some insect which inserts the poison under the skin. He also considers that the soil of certain limited areas is the medium in which the germ grows and produces the specific poison, and in these areas the disease is endemic. He also believes that this germ can be transported from place to place and under certain suitable conditions it can grow and multiply like any other living organism.

Dr Hamilton Wright[35]'s theory is as follows.: Beri-beri is due to a specific organism that remains dormant in certain localities, but having gained entrance to the body by the mouth, it multiplies locally (in the stomach or duodenum chiefly), gives rise to a local lesion and produces a toxin which, entering the general circulation, acts on the peripheral terminations of both afferent and efferent ordinary and vital neurones, to cause a bilateral symmetrical atrophy;and that finally the organism escapes in the faeces to again lie dormant. He thinks the germ enters mixed with contaminated food, and this he has proved by experiments on monkeys cooped up in endemic areas, viz. the new prison at Kwala Lumpur. They were fed on fresh fruit which was first rubbed on the ground to become contaminated. The monkeys in many cases showed symptoms of beri-beri.

Thus we see that both Manson and Wright consider the disease to be a "disease of place", but differ in their theories as to the action of the germ. The weak point in Wright's theory is that he has never discovered a characteristic bacterium in either the blood or the tissues of the duodenum or stomach, where the local lesion is found. He puts the incubation period at from 10 to 15 days.

Dr Wright also experimented on monkeys to find if the faeces of men contained this germ. The disease occurs to a great extent amongst Chinese tin miners who eat vegetables top-dressed with human faeces. Solutions of this faeces were given to monkeys, but the results were negative.

Parasitic theories: By many observers it was thought that the intestinal parasites, viz., Ankylostomum duodenale or Tricocephalus dispar. This theory was held by Prof. Kynsey[36] of Ceylon. Others have thought that Filaria nocturna might be a cause. This has been entirely refuted by the fact that these intestinal worms and their ova are found present in the faeces of hundreds of people living in areas entirely free from beri-beri, and Filaria Nocturna and its ova are also found present in the blood of hundreds of people living under like conditions.

Arsenical Poisoning: This has recently been advanced as a cause of the disease by Dr R. Ross[37] and Reynolds[37].

Dr Ross found arsenic in the hair of 21 cases of beri-beri in Penang and Adanpur, and in several cases from Singapore. During the arsenical poisoning from beer in England, in 1900-01, symptoms like those of beri-beri appeared; but the pigmentation and other skin affections, eye affections, etc. seen in arsenical poisoning are never present in beri-beri.

We can scarcely accept this theory as a cause of beri-beri, as the latter disease has been found in many places where arsenic was entirely absent, e.g. in all the observations made in prisons in Kwala Lumpur, arsenic was proved to be absent. Of course there is no doubt that amongst the Chinese who work in the tin mines where arsenic abounds, the disease is very prevalent, but in opposition to this it has been noted that amongst the Tamils, who act as ore workers, the disease is seldom if ever found.

Of all the theories advanced to account for the cause of beri-beri, I am most inclined to believe in those of Manson and Hamilton Wright. The theory of the former is weak in one point, viz., the obscurity as to the means of entrance of the toxin. The latter's weak point is the inability to discover the germ. I have never seen any specific germ in either the blood or tissues of beri-beri cases which might be fairly described as the specific germ of the disease.

From my own observations in different epidemics in India, East Africa, the Malay Straits, China, Japan, and Dutch Guiana, I have been led to the following conclusions:-

(1) That the disease is a "place disease" and is endemic only in limited areas. I have found the disease raging in one camp, while close by other camps have been entirely exempt.

(2) That the disease is not due to a germ living and multiplying in the body, but is due to a germ outside the body, which produces a toxin that causes the disease on entering the body. In this I entirely agree with Manson, as like him I have noticed how rapidly improvement occurs on removal from

the infective area, an improvement which could not take place so rapidly if the germ were present in the body.

(3) That diet, or rather deficiency in any one factor of diet, has no causative effect, though I believe that where men are kept on continued salt, tinned, or bad food, they are rendered more susceptible to the disease.

(4) That the disease occurs in epidemics where we have large communities of people gathered together, such as in institutes, mining camps, etc., and that though overcrowding is not a necessary factor, the outbreak is favoured by this condition.

(5) That the disease is also favoured by living in low-lying marshylands and especially those which are never exposed to sunlight.

(6) That it is favoured by bad ventilation, and the absence of good sanitation.

(7) That people rendered weak by privation, overwork, previous disease, etc., are more liable to attack and to increased severity of the disease.

(8) That the disease can infect people through open sores. I have seen this several times in hosp-

itals in different parts of the world, where we had patients lying with open sores after operation or with phagaedenic ulceration. These patients when exposed to infection from other beri-beri patients, or if lying in an endemic area, are extremely liable to infection.

SPREAD OF BERI-BERI:

There is no doubt that the germ which produces the toxin that causes beri-beri can be carried from place to place. Dr Bolton[38] describes an epidemic in Diego Garcia. The disease was brought to the island by labourers from the island of Glorieuse. It first broke out amongst them and later on infected some of the islanders. Out of 21 attacked, 9 died. This disease had never been seen in the island before and after these labourers left, it quickly disappeared. Noble Joynt[39] also describes its introduction to Fiji by Japanese immigrants. Here also it disappeared when they left and returned to Japan.

Communicability:

The question as to the communicability of beri-beri by direct infection must still be considered

unsettled. In many gaols, prisons and hospitals, where the disease has never been known to exist previously, outbreaks have occurred on the admission of patients known to be suffering from beri-beri. My opinion is that this only occurs in certain places, where a suitable medium is present for the growth of the specific germ. I do not believe that the disease is transmitted directly from patient to patient, I think that the cause of the spread of the disease in the above conditions, is due to the fact that the beri-beri patients introduced may bear on their clothes or skin the specific germ; that this germ meeting with a suitable medium for its growth, at once begins to multiply and produce the necessary toxin for the development of the disease, and this toxin being inhaled or absorbed through open wounds of other patients, causes an outbreak of beri-beri amongst them.

I base this statement on facts I have myself noticed. I have seen beri-beri patients lying alongside other patients suffering from other diseases with no spreading of the disease as a result of their close contact. In other cases I have seen the disease spread to other patients under the same conditions. I think it all depends on the nature of

the surrounding media. If these are suitable for the spread, then if germs are introduced they will grow and multiply; if the surrounding media are unsuitable, the germs will die.

I have not the least doubt that there are many places in which the soil is suitable for the growth of this germ, but no disease occurs there for the simple reason that the vital spark has not yet been introduced.

During one's travels in the tropics one sees many places which seem to be alike in nature, but in some of them beri-beri is absent, while in others it is a scourge.

Waterhouse[40] considers that infection by personal contact and by place infection is probable. He found that in a prison with 100 inmates the disease was unknown until two cases of beri-beri were introduced, and after that the disease spread. The buildings were neither old nor damp, and no flies or mosquitoes were present. The persons most liable to attack were those who occupied unfloored tents and walked about with bare feet. He also noticed that the disease occurred only in one set of quarters, and that the number infected decreased when the floor was scrubbed with a 4% solution of chloride of lime. I think this is very good evidence in support of my theory that

the disease is spread only indirectly from patient to patient, and not by direct contact.

Dr Stanley[41], after observations made in four prisons in Shanghai, makes the following statements:

(1) Beri-beri is more frequent among prisoners and police than amongst the general public.

(2) It is found especially in prisons where the inmates have been together for a long time, e.g. in long sentence prisons.

(3) It is not due to soil or place infection, as he found that in the four prisons the European and Indian staffs escaped, though they resided along with the prisoners who suffered.

(4) Food infection is not a factor, as in three out of four prisons the food came from different sources, except the rice which was all supplied by one contractor. An absolutely pure rice was given but no decrease took place.

(5) He thinks the spread of the disease is due to contagion. In this I cannot agree with him, and I do not think that the evidence he brings forward to support this hypothesis is sufficient.

CHEMISTRY OF THE BLOOD IN BERI-BERI:

Mott and Halliburton[42] found the presence of cholin and neurin in the blood of beri-beri patients, but in addition they found on one occasion a toxic effect from beri-beric blood that could not be explained by the presence of cholin or meurin, which are simply the result of nerve degeneration.

The chemistry of the blood in beri-beri is so far of very little help in assisting us as to the etiology of the disease.

Dr Max F. Simon,[43] however, in his paper, "The known and the unknown in respect of beri-beri", makes the statement that in his opinion the best chance for the discovery of the cause of beri-beri lies in the domain of the pathological chemist, in his investigations of the chemistry of the blood.

COURSE AND PROGRESS OF CASES:

The disease, as has been seen, commences abruptly or insidiously. We may have primary symptoms which come and go before the disease commences properly, or the symptoms may come on and reach their height in less than 24 hours. The course of the disease is also uncertain. It may subside in a few days or go on for months or years.

Liability to danger is also uncertain. We may get sudden heart affection or affection of phrenic nerves causing immediate death, or these nerves may escape entirely.

We may get apparent recovery followed by relapses; we may get complete recovery; or we may get the patient left with a dilated heart, or atrophied limb muscles, resulting in deformity. It is wonderful to note how apparently hopeless cases recover gradually and finally become quite well again. But on the other hand, again, it is very disappointing to find cases, which are apparently going on well, suddenly attacked by acute cardiac symptoms, resulting in death from syncope or slow heart failure.

DIAGNOSIS:

The diagnosis of this disease when it occurs in epidemics is not difficult. Where we get peripheral neuritis occurring epidemically, in a place where it has been found before, and where along with this neuritis we find cardiac symptoms, and symptoms of oedema, we may set it down as beri-beri. Where the disease occurs sporadically, it is more difficult to diagnose and may be confused with alcoholic neuritis; but inquiries into the previous history of the patient, along with the facts that in beri-beri there are no

tremors, and that the characteristic heart signs are present, usually settles the diagnosis.

Differential Diagnosis:

1. From Alcoholic neuritis: as above.

2. Subacute anterior polio-myelitis: In beri-beri superficial reflexes are never lost, the sensory symptoms are marked, the muscles of the head and neck and even the trunk, are rarely affected, no bulbar paralysis is present, and initial febrile symptoms are often present.

Epidemicity of beri-beri is also an important factor.

Ankylostomiasis:

Here we find that the constipation so usual in ankylostomiasis is absent in beri-beri, and the characteristic ova, though sometimes present are not common.

Scurvy:

No haemorrhages and ulcers are found in beri-beri.

Chronic granular kidney

In beri-beri the urine as a rule contains no albumin, and the heart dullness is usually to the right, whereas in chronic renal disease the dulness is always to the left.

Muscular Rheumatism;

This is rare in the tropics. In suspicious cases look for oedema, absence of knee jerks and hyper-aesthesia of muscles.

Landry's Paralysis:

Here the history is important. Here we get no epidemic history, and no heart symptoms.

Arsenical Poisoning

Here the pigmentation and the eye affections are characteristic.

Locomotor Ataxy:

Has been the diagnosis in cases of beri-beri. Here the history often settles the question, along with the absence of an epidemic history, the presence of the typical pupil sign, and the atrophy of the optic nerves.

PROGNOSIS:

This should always be guarded, so long as the patient is in the endemic area, or so long as the disease is active. One never knows the minute when an acute cardiac attack resulting in death, may occur. The great danger, as I have said before, lies in the

liability if attack to which vital nerves are prone. This is found even in the mildest of cases.

Any symptoms or signs pointing to serious heart implication are most unfavourable such as pulsation in the carotid arteries and jugular veins, increase of heart dulness to the right, epigastric pulsation, rapid, irregular and feeble pulse, marked cyanosis, cold feet and hands, acute dyspnoea or spacing of the cardiac sounds.

Diaphragmatic palsy, paresis of intercostal and abdominal muscles, vomiting, uraemic symptoms, dilatation of the stomach, and the presence of much serous effusion are also serious signs.

The prognosis of the disease is more favourable when the patient can be removed early from the endemic area, and placed in a high locality.

MORTALITY AND MODE OF DEATH:

The mortality varies very much in different epidemics. In some epidemics it is as high as 40% or even 45% of those attacked; in others it may be as low as 4% or even 2%.

In acute pernicious cases death always occurs; in acute cases it occurs oftener than in subacute and residual- paralytic cases. In dropsical cases

it is usually very high. Where the cases can be removed quickly to a non-endemic area, the disease always proves less fatal. The usual cause of death is dilatation of the right side of the heart. This dilatation, to begin with, is due to the implication of the cardiac plexus, and pneumogastric nerve. As a result of this we get weakening and degeneration of the cardiac muscle, and irregular heart action from the interrupted nerve supply. When this once begins, the dilatation tends to increase, owing to the difficulty the heart has in contracting on the blood within it. The tricuspid valve becomes incompetent and the blood begins to stagnate on the right side of the heart. Then all the symptoms of backward pressure may appear. The vessels in the root of the neck begin to show pulsation and engorgement. The condition is aggravated by the serous effusion in the pleural cavities, and by oedema of the lungs, also by dilatation of the stomach and paresis of the diaphragm.

Death sometimes occurs from syncope, but as a rule it is due to slow heart failure, complicated by oedema of the lungs, paresis of the diaphragm and the effusion into the cavities of the pleurae and pericardium. Occasionally uraemia is the cause of death.

TREATMENT:

Prophylactic: In the Journal of Tropical Medicine, September 1899, Dr M. F. Simon[45] discusses the question of prophylaxis in this disease. The attempts in this direction so far have been chiefly dietetic or hygienic, by giving a good nitrogenous diet and by seeing to the proper ventilation of dwellings in endemic areas much has been done. Arsenic as a prophylactic has been tried, also strychnine. The latter was used by Ellis[46] of Singapore, but lately the results have been very unsatisfactory. Ph. Laoh[47], a native observer, who advanced the view that the disease was liable to occur in people who were restricted to one food, and always used the same diet, found that by using certain spices in the food and by substituting for rice the pea or bean of the plant named Phaseolus radiatus, also by giving a varied diet, that the outbreaks become fewer in number and the type more mild.

I think the following measures ought always to be taken:

1. Houses in endemic areas should be built on piles so that sleeping places may be as far removed from the ground as possible.

2. Houses should be well-ventilated and be open to as much sunlight as possible.

3. The floors should be regularly washed with a 4% solution of chloride of lime or a solution of Jeye's fluid.

4. Food should be fresh and should contain plenty of nitrogenous matter. Fresh vegetables should be used in plenty.

So far no drug has been found of use.

Treatment of Epidemics: Where an epidemic breaks out the building or buildings should at once be emptied of the inmates and thoroughly cleaned, ventilated and exposed to sunlight. Those affected should, if possible, be at once removed to a high and dry locality, free from the disease and treated as I shall describe below. Others who have not contracted the disease, but who have been exposed to it, should be kept under observation, and if the characteristic symptoms appear, they should be treated as above, and sent along with those already sick.

While under observation, patients must not be cooped up, but kept in the open and in the sun as much as possible.

Make enquiries into the dietary of the affected place, and if necessary improve it. If the building is in a very insanitary condition and the floors

are low lying, it should be pulled down and reconstructed on piles. Examine people under observation every day.

Schuttelaure[48] found that in two epidemics at Diego-Suarez the first disappeared by increasing fat in the diet; in the second the disease was arrested by the substitution of fresh bread and fresh non-decorticated rice for rice which had grown old and mouldy. By this he shows that where the health of the men had deteriorated and beri-beri had broken out, it was arrested in its epidemic course by giving fresh, wholesome food.

Treatment of the Disease in Individuals: This of course includes the treatment of individuals of an epidemic, as well as sporadic cases.

The first, and a very important point, is the removal of all cases from the endemic area to a high, dry and non-endemic locality. The hospital or house should be dry, clean and well raised from the ground. It should be well-ventilated and open to sunlight. The patients should be warmly clad in flannel or flannelette and should never be confined to bed unless serious heart trouble sets in.

Diet: Except in dropsical cases where a strict milk diet is indicated, the patient should have a nourishing diet. Rice should be excluded, as it

is liable to cause distension of the stomach and cause an increase of epigastric discomfort.

Wheat, oatmeal, beans and peas are good substitutes. Fresh vegetables, fresh fruit, fresh meat, and poultry are of great use. Always keep in mind the fact that a bulky diet is deleterious and select foods which contain most nourishment in the smallest space. Fat and nitrogenous matters should always be present. Milk and eggs may be given. In serious heart cases give as dry a diet as possible.

The pea or bean of Phaseolus radiatus is useful as a substitute for rice.

Drugs: As yet, no drug has been found specific.

Dr McLosky(49) has described the treatment of 38 cases of beri-beri with arsenic at Kwala Lumpur The results were most unsatisfactory. Out of the 38 cases treated 14 died, 20 were discharged and 4 absconded. The experiment was made on chronic cases. He began by giving M.iii thrice daily and increased the dose to M.x. ter in die. I have tried ipecacuanha in a large number of cases, but got no results to my satisfaction.

Where cardiac trouble is present, digitalis or strophanthus combined with strychnine and squills is of great use.

Where symptoms of acute cardiac dilatation supervene, liquor tri-nitrini, in doses of M.iii-v. given every quarter of an hour till the symptoms abate, is useful. Sodium nitrite and inhalations of amyl-nitrite are also useful under these conditions.

Where these means fail, venesection may be beneficial. Six or ten ounces of blood drawn from the arm or the external jugular vein may relieve the symptoms. Where venesection is resorted to a hypodermic injection of Caffeine should be administered immediately afterwards.

When acute symptoms have abated, resume the use of digitalis.

For atrophy of muscles and sensory symptoms the faradic and galvanic currents along with massage may be found of great use. This must not be begun, however, till all muscular hyperaesthesia has disappeared. All deformities must be treated by the use of splints. In the later stages, strychnine, arsenic and silver nitrate may be found useful as tonics. Always attend to the bowels, and if necessary give mild salines.

In extreme dropsical cases keep the patient en-

tirely at rest. First give a good hydragogue purgative, such as Pulv.Jalap. Co. or Elaterium, then keep the bowels freely open with salines. Overcome diminution of urine by diuretics, such as digitalis, Scoparium, diuretin, etc. Diuretin is very useful and should be given in 10 grain doses three times a day.

Where suppression of urine and uraemic symptoms appear, use pilocarpin in doses of gr.1/6 to 1/4, three or four times a day.

Where serous effusions become serious and interfere with circulation or respiration, the aspirator may be used, or Southey's apparatus.

Anaemia may be treated in the later stages by iron and arsenic. Where the ova of ankylostomiasis are present, they should be got rid of by the administration of thymol.

Dr P. T. Carpenter[50] of British North Borneo, considers that there are four principal agents in the treatment of beri-beri which have a curative effect:

1. Strychnine by mouth or hypodermically.
2. Application of Faradic or Galvanic currents to the affected muscles.
3. A generous nitrogenous diet, combined with a sufficiency of fresh vegetables.
4. Removal from the endemic area.

Dr R. McLean Gibson[51] of Hong-kong has found that a diet of beans and fat pork, combined with the use of digitalis, iron, phosphoric acid, arsenic and strychnine, have been of great advantage. The drugs he used especially during convalescence. He also found that the muscles when rubbed with Linimentum terebinthinae were greatly benefited.

After-treatment: Sea voyages are often of great benefit to patients recovering from the disease. A return to any endemic area must always be avoided. One attack of this disease only renders people more liable to other attacks; no immunity is conferred.

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